Appendix H

Soil Properties

Bridges ultimately transfer all of their loads to the earth. Unless the foundation is on bedrock, the bridge will transfer loads through the soil. This appendix provides approximate values for several key soil characteristics *(Table H-1; Tables H-2* and *H-3, page H-2;* and *Figure H-1, page H-3).* Due to the large degree of variance in these characteristics, the actual values from field tests should be obtained whenever possible.

Table H-1. Soil Properties

Soil Type	Characteristics	Symbol	Unit Weight (u) (lb/cu ft)	Angle of Internal Friction (θ) (deg)	Soil Bearing Capacity (ksf)
Sand	Loose and dry	SW to SP	89 to 107	31	3
	Loose and damp		99 to 117	31	3
	Loose and saturated		108 to 134	31	3
	Dense and dry		114 to 118	32.5	5
	Dense and damp		124 to 127	32.5	5
	Dense and saturated		134 to 137	32.5	5
	Compact and dry		121 to 127	33.5	10
	Compact and damp		128 to 135	33.5	10
	Compact and saturated		138 to 142	33.5	10
	Sand (sand clay)	SC	129 to 141	22 to 26	5
Gravel	Loose and dry	GW to GP	112 to 118	30	4
	Loose and damp		115 to 122	30	4
	Loose and saturated		136 to 142	30	4
	Dense and dry		136	33.5	12
	Dense and damp		140	33.5	12
	Dense and saturated		149	33.5	12
Clay	Sandy	CL (with sand)	114 to 135	16 to 22	5
	Stiff	CH	—	—	5
	Very stiff		—	—	6
Soil	Organic	OH	69 to 88	22 to 26	3
Rock	Soft and fractured	—	—	—	20
	Hard and solid	—	—	—	40

Table H-2. Friction Coefficients

Material	Friction Coefficient (K_f)
Concrete on concrete	0.65
Concrete on wood (with grain)	0.60
Concrete on wood (against grain)	0.50
Concrete on dry clay	0.50
Concrete on wet clay	0.33
Concrete on sand	0.40
Concrete on gravel	0.60

Table H-3. Friction Between Pile and Soil

Soil Type	Characteristics	Allowable Friction (ksf)[1]
Fine-grained soils	Mud	0.0125 ± 0.100
	Silt	0.1500 ± 0.100
	Soft clay	0.2000 ± 0.100
	Silty clay	0.3000 ± 0.100
	Sandy clay	0.3000 ± 0.100
	Medium clay	0.3500 ± 0.100
	Sandy silt	0.4000 ± 0.100
	Firm clay	0.4500 ± 0.100
	Dense, silty clay	0.6000 ± 0.150
	Hard (stiff) clay	0.7500 ± 0.200
Coarse-grained soils	Very loose sand and silt or clay	0.1000 ± 0.025
	Medium sand and silt or clay	0.2500 ± 0.050
	Dense sand and silt or clay	0.3500 ± 0.050
	Very dense sand and silt or clay	0.4500 ± 0.050
	Sand (all densities)	0.6000 ± 0.250
	Sand and gravel[2]	1.0000 ± 0.500
	Gravel	1.2500 ± 0.500

NOTES:

1. Allowable values are based on a safety factor of 2. Thus, the ultimate value is equal to twice the allowable value.

2. Apply this vaule if not micaceous, muddy, or under hydrostatic pressure or vibration.

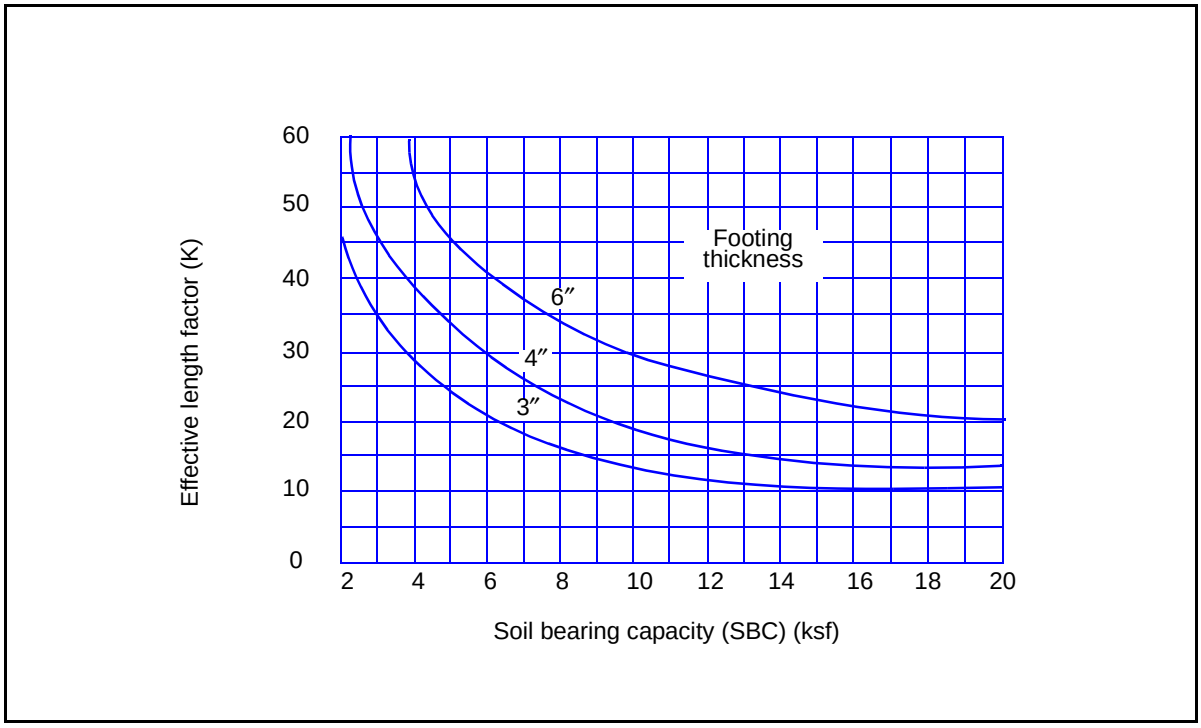

Figure H-1. Footing Length Factor